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# THESIS

PREDICTING PRICING STRATEGY FROM  
FINANCIAL CONDITION

by

Kurtis James McGrath

December 1986

Thesis Advisor:

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Predicting Pricing Strategy From Financial Condition

by

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requirements for the degree of

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## ABSTRACT

The purpose of this research is to determine if pricing strategy for pioneer products in the defense aerospace industry can be predicted using financial ratios. The sample population includes eleven contractors and thirty five contracts. Fifteen ratios were developed from corporate reports or 10K reports for the year of the contract and the three preceeding years. These ratios were correlated to the slope of the price reduction curve for the contracts. The analysis used both standard and stepwise regression methods. A nine variable, linear regression model was developed that is significant in explaining pricing strategy. The model possesses potential to predict pricing strategy but requires additional validation.

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## I. INTRODUCTION

### A. BACKGROUND

The business of acquiring major weapon systems for the Department of Defense (DoD) is characterized by: extensive regulatory complexity; close scrutiny by the Congress, Executive Department and the public constituencies; a less than competitively disciplined market; and enormous size.

The Honorable John F. Lehman, Secretary of the Navy, noted that "By actual measurement, current laws and regulations on defense procurement fill 1,152 linear feet of law library shelf space." [1:76]. Virtually every aspect of the acquisition cycle is addressed within this voluminous body including special interest and socio-economic programs. Contradictions in writing and interpretation have arisen. The flow of Congressional dictates has accelerated in recent years and shows no sign of abatement.

The media and members of the body politic have exacerbated the process through sensationalistic exposes highlighting overpricing of ashtrays, coffee pots and toilet seats. In result, a credibility gap has opened between the tax payer and those engaged in procurement for DoD. Intense scrutiny by the public, Congress and the Executive branch are perceived to be necessary to ensure the apt use of public funds.



The defense procurement market is not classically competitive because of its monopsonistic buyer, DoD, and its oligopolistic prime contractors. In some cases sole source procurements have led to the creation of a monopolistic seller and a bilateral monopoly market structure. The absence of true competition has allowed both price and production inefficiency to exist. The Competition in Contracting Act of 1984 (CICA) and budgetary constraints have led to greater direct competition by seeking to establish "full and open competition" in the sealed bid and competitive negotiation process. National fiscal constraints create indirect competition through alternative uses of funds, guns or butter, and indirect competition exists from alternative weapon systems or strategic application with the proposed new weapon system. However, the unique, innovative and limited use products created in the defense market will continue to trend away from classical competition and its disciplined market. Olvey, Golden, and Kelly provide a basic discussion of defense economic market structures in their text The Economics of National Security. [2:193-202]

In a recently concluded study one congressional investigator noted:

The Department of Defense is by far the largest and most complex organization in the world, employing more than 3 million people, operating over 5,600 installations around the world and executing over 15 million contracts per year with some 300,000 contractors. [3:1]

Acquisition support for this behemoth encompasses "... 170 billion dollars annually, 56,000 contract actions daily...." and "...165,000 military and civilian employees." [4:43]

Within this caldron of activity it is the government contracting officer who bears the responsibility to obligate public funds, by signature on a contract, for each of those 56,000 actions daily. The three basic types of contracting officers are the procurement (PCO), administrative (ACO) and termination (TCO) contracting officer.

Acquisition of major weapon systems (MWS) by a PCO in the defense aerospace industry is the specific subset addressed in this research.

## B. OBJECTIVE

The objective of this research is to investigate the possible presence of a relationship between a corporation's financial condition and it's pricing strategy of pioneer products in the defense aerospace industry. If such a relationship exists and can be predicted then an analytical tool that indicates potential pricing strategy can be developed for use by a PCO in the conduct of competitive negotiations.

### C. RESEARCH QUESTION

Does an identifiable, predictable relationship exist between corporate financial condition and pioneer product pricing strategy in the DoD aerospace industry?

- (1) What is pricing strategy including the specific elements related to pioneer products?
- (2) What is financial condition including the elements that comprise it and the standards used for it's measure?
- (3) How are pricing strategies related to financial condition?

### D. SUMMARY OF FINDINGS

The relationship between the slope of the price reduction curve and financial ratios reflecting a firms financial condition was of primary interest. The approach used was to statistically relate price reduction curves with ratios and combinations of ratios.

The statistical methods used were; a correlation analysis of the individual ratios for each year, a regression analysis using all ratios for each year, a stepwise forward select regression analysis with all ratios and a progressive regression analysis adding ratios in the sequence of significance determined in the stepwise regression.

This statistical analysis procedure obtained the following results.

- (1) The univariate correlation analysis revealed generally low correlation coefficients, however, the

anticipated signs of the correlation coefficients for each ratio did match the hypothesized signs in eleven of fifteen instances.

- (2) Multivariate regression analysis of the slope of the price reduction curve on the set of financial ratios provided r-squared values up to 73.3, indicating an ability of combinations of financial ratios to explain pricing strategy
- (3) A "best" model including nine ratios, which had an r-squared of 70.7 and r-squared adjusted of 50.4, was identified.

The model indicates that financial ratios are related to pricing strategy and holds forth potential for future investigative effort to establish its validity through application to other sample populations.

#### E. ORGANIZATION OF STUDY

Chapter two discusses the background conceptual and theoretical framework, addressing: Greer's [5] efforts relating interperiod cost allocation methods and price reduction curve slope with pricing strategy; a basic explanation of learning curve theory and its extension to the concept of a price reduction curve; and, the rationale for hypothesizing that existing financial condition could predict pricing strategy.

Chapter three addresses pricing strategy in general and specifically treats the pioneer product pricing strategies of skimming and penetration.

Chapter four deals with financial condition, sources of financial ratios, categorization of ratios and the rationale



for the selection of certain ratios for use in this study. The source of raw data and number of financial data elements used in the ratios is presented.

Chapter five presents the method of analysis, including; a univariate correlation analysis, linear regression analysis with all independent variables, a forward select stepwise regression analysis and finally a progressive linear regression analysis adding independent variables in the sequence developed by the stepwise regression. Attention is devoted to the anticipated behavior of the independent variables and the results obtained from the correlation analysis.

Chapter six provides the conclusions of the research and recommendations for further research.

## II. CONCEPTUAL AND THEORETICAL FRAMEWORK

### A. INTRODUCTION

This chapter discusses the underlying conceptual and theoretical framework of this research. Dr. Willis Greer's article "Early Detection of a Seller's Pricing Strategy" is looked at for its role in providing the impetus for the research hypothesis. A brief discussion of the theory of learning curves is presented, which is essential to an understanding of the research hypothesis. Finally, assumptions are presented concerning the relationship between: corporate management goals and the supporting goals established by the financial and pricing functional areas, and the predictive relationship between financial condition and pricing strategy.

### B. GREER ARTICLE

Dr. Willis R. Greer Jr., Chairman of the Administrative Sciences Department, Naval Postgraduate School, demonstrated a strong relationship of interperiod cost allocation methods for depreciation and inventory with the slope of price reduction curves of major defense, aerospace contracts.

Steep price reduction curves are associated with a skimming pricing strategy: a high initial price with reductions over the life of the product. Flatter price

reduction curves are associated with a penetration strategy: a low entry price that basically remains constant throughout the product's life.

Dr. Greer hypothesized that accelerated depreciation and inventory costing methods would be associated with high initial price followed by a relatively steep price reduction curve; and that depreciation and inventory costing methods that spread costs out more evenly across the product's life would be associated with a relatively level price reduction curve. [5:6-12]

His linear regression model obtained an r-squared value of 91.7% with a t-ratio of +6.33 for depreciation and +3.59 for inventory.

The implication of Dr. Greer's efforts are that pricing strategy might be predictable based upon accounting methods selected for the reporting of depreciation and inventory costing. The present research hypothesizes that financial condition, determinable from accounting data, might also possess a predictive capacity for pricing strategy.

#### C. LEARNING/PRICE REDUCTION CURVE

The learning curve concept originated from the observation that individuals performing repetitive tasks tend to exhibit a rate of improvement. [6:3-28] However, there are many reasons for reduction of input costs to manufacturing over repetitive operations; more efficient

labor, less material from reduced scrap and waste, and higher productivity from improved processes. Thus the learning curve can also be referred to as a cost reduction curve.

The cost reduction curve shows a trend relationship between the number of opportunities to learn and cost input per constant unit of production. [6:3-29] "As the total quantity of units produced doubles, the cost per unit decreases by some constant percentage." [6:3-29]

A per unit reduction can be extended conceptually to the measure of price per unit. Thus the learning curve concept can also be portrayed as a price reduction curve.

The learning curve function relates a dependent variable (price) with an independent variable (volume) as follows:

$$C = AX^B$$

Where C is the cost of the Xth unit produced and A is the cost of the first unit. If costs are level as volume (X) increases then the exponent B would be zero. B is negative when costs decline with volume. The slope of the learning curve, S, is related to B as follows:

$$B = \frac{\ln S}{\ln 2}$$

A slope of 1.00 implies a horizontal line - i.e., no price reduction. The lower the decimal value of the slope, the higher the price reduction rate. For example, .800 is a steeper (faster) price reduction rate than .900.



The price reduction slopes used in this study are the actual slopes exhibited as calculated after completion of contract performance. [7]

#### D. ASSUMPTIONS

The goals established by corporate management form the fundamental framework within which all elements of the corporation will operate. They are the common denominator toward which each of the functional management areas will structure their individual goals.

The marketing and financial functional organizations of a corporation are subsets that contribute to the operation of the corporation by executing their responsibilities in a manner that directly contributes to the realization of the overall corporation established goals. Their individual objectives should directly support and contribute to corporate goal achievement. Since both are working toward the same ends they should be mutually supportive and interrelated, and consequently at least an indirect link between financial and marketing goals is assumed.

Financial goals are measureable in terms of corporate financial condition. The quantitative tool for this measurement are financial ratios developed from the elements of information presented in financial reports.

In this study financial condition is determined using fifteen representative ratios computed for each year

observed. The years used are the three years prior to the contract and the year in which the contract began. These ratios will be investigated to determine their relationship with the actual price reduction slope experienced for the thirty five contracts comprising the sample population.

The researcher's assumption is that the relationship between financial ratios and price reduction curves exhibited for the thirty five sample government contracts in this study may be useful to predict the price reduction curve in future contractual actions.

### III. PRICING STRATEGY

#### A. INTRODUCTION

"The price a company charges for its products or services can determine the success or failure of the companies overall business plan." [8:71] As such, the pricing strategy chosen that supports the proffered price must be linked carefully to the overall, long term goals of the company.

The broadest goal of publicly held corporations is to maximize the wealth of the shareholders through achievement of the highest possible market value of the firm. There are a broad range of objectives established by companies that influence the manner in which this primary goal is pursued. Pricing objectives, supported by specific strategies, are one of many kinds of objectives (i.e., production, research, marketing, and financial objectives) that make up the entire corporate set of objectives.

The price received by a firm for its products represents the inflow of revenue from a market place exchange for the expenditure of its efforts. In the defense aerospace market the price of a product is often the result of negotiations between the Department of Defense (DoD), a monopsonistic buyer, and an oligopolistic seller. In this imperfectly competitive environment it is assumed that a fair and

reasonable price will be established for both parties through the negotiation process.

The product being offered in the Major Weapons System (MWS) arena is often an innovative, never before offered item with a very limited market application.

A weapon system is usually a combination of state-of-the-art hardware and specialized services. A weapons system's contract may call for the development of a product which has not been invented, or the production of an item that has barely been invented. Yet, such products are considered vital to national security, and they are procured by contracts involving extraordinary sums of money outside of the market structure where established prices prevail. [9:3]

Dean's definition of a pioneer product is:

. . . one which incorporates a major innovation. Its market is therefore, at the outset, ill-defined, since potential application cannot be foreseen with precision. Pricing decisions usually have to be made recognizing wide margins of error in the forecasts of demand, cost and competitor's capabilities. [10:165]

The pricing of a new major weapons system certainly appears to fit into the category of pricing pioneer products.

An advantage would accrue to the buyer in the negotiation process if the pricing strategy of the seller could be discerned. The buyer would be able to press for favorable concessions from the seller through the use of greater knowledge over the seller. The ability to identify the pricing strategy of a pioneer product from the financial condition of a corporation would be desirable. The financial health of a corporation is identifiable through an



analysis of financial ratios for the industry and specific firm.

## B. CORPORATE AND PRICING OBJECTIVES

### 1. Corporate Objectives

In simple terms the overall objective of any company is to maximize profits - Firstly, in order to survive; secondly, to provide dividends to the shareholders; and thirdly, to provide a fund for investing in new products, personnel, and plant and machinery to assist in attaining future profit goals. [11:527]

The idea that companies are first and foremost profit maximizers is commonly held but simplistic in todays complex, defense market environment.

In his comprehensive analysis of incentive contractual arrangements within the defense market, Kennedy developed a list of factors other than profit that influenced corporations. [12:1-3; 13:218] These factors are: (sequence does not denote importance)

- Follow-on production.
- Current capacity.
- Reputation and prestige.
- The need for technical excellence for future competitive advantage.
- Corporate growth.
- Commercial spin-off.
- Market position or share.
- Personal goals of key executives.

Executive goals are linked to management performance measurement. Kennedy states "Since ROI, cash flow and market share were utilized to measure management achievement, these were important in determining corporate behavior." [11:I-3,4]

The Defense Financial and Investment Review (DFAIR) study published in June, 1985 identified six generic goals during interviews with eleven major defense contractors. [14:III-5,6]

- To obtain a return on investors equity greater than government, risk free securities generally 15% to 20% after taxes.
- To effectively manage production inputs of material, labor and capital so as to achieve adequate return on investment (ROI).
- To allocate resources for and choose activities with the highest expected return over the long term.
- To reduce short-term risk from cyclic market activity through long-term investment in diversified activities.
- To properly employ financial and equity leverage.
- To achieve operating effectiveness and efficiency.

A wide variety of risks are incurred by defense contractors which have a significant impact upon their behavior and goals. Some of the most prominent risk factors are: those associated with advanced technology and design subject to the vagaries of newness and the pursuit of evolving newer ideas; the ups and downs of the congressional budget process that can be changed annually; the national political situation and debate over guns or butter; and the

world political situation and its impact on national budgeting. Kennedy refers to the works of Moore and Cozzolino on risk assumption citing ". . . the level of perceived risk was such that contractors acted to reduce risk and not to maximize profits." [12:I-6]

Kennedy summarizes his treatment of corporate goals by saying "Depending on the time frame (short run, long run), the nature of the company, the nature of its products, the size of the contracts, the general health of the company and the general economic climate, its goals vary." [12:I-8] In his paper presented at the 1985 Federal Acquisition Research Symposium, Kennedy makes the characterization that "...large aerospace firms are risk adverse and profit satisfiers, and cost maximizers." [13:218]

## 2. Pricing Objectives

Pricing objectives form a framework for pricing decisions that promote consistency in support of overall corporate objectives. These pricing decisions will be implemented in the form of pricing strategies. A sample list of pricing objectives follows. [8:73]

- To increase profitability.
- To increase sales.
- To gain market share or increase existing share.
- To eliminate competition.

- To promote an image of quality, service or prestige.
- To discourage new competitors from entering market.

These pricing objectives display a supportive identifiable relationship with the corporate strategies previously listed, but not necessarily on a one-to-one basis. Increased profitability relates to key executive performance measures of ROI and cash flow. Increased sales and market share supports corporate growth and corporate market position. The elimination or discouragement of competition will affect current capacity and follow-on production potential. A product's prestige is also tied to the prestige of the corporation.

This basic interrelationship of corporate and pricing objectives should be exhibited in the selection and execution of a pricing strategy.

## C. PRICING STRATEGY

### 1. Types of Strategies

There are a wide variety of pricing strategies available to select from in the market place. The problem is to select the strategy that meets or exceeds pricing objectives for a given product in its peculiar market environment. The following list is representative of the variety of strategies available. [8:74-77]

- a. Cost plus: sum of fixed, variable and semi-variable costs plus some profit margin.

- b. Mark-up: straight percent over cost without regard to customer.
- c. Consumer based: consumer needs paramount over cost considerations.
- d. Inflation: balance forecasted inflationary increases against the expected learning rate.
- e. Competitive: based upon competitors price with choice of higher, lower or equal.
- f. Skimming: enter high and progressively reduce price to obtain more market segments over time.
- g. Low balling: aggressive, very low pricing to obtain the maximum market segment in the minimum time.
- h. Penetration: initial price low with little reduction over time, obtaining return from volume.
- i. Opportunistic (monopolistic): all the market will bear.
- j. Defensive: low or lower price to protect current market share or discourage entry by competitors.
- k. Price milking: higher than normal market at the end of the products life cycle to extract profit from loyal customers.
- l. Demand oriented: weak demand, low price; strong demand, high price.

## 2. Pricing Strategy Selection Considerations

In his discussion of new product pricing James developed five considerations to weight, as appropriate, in a particular commercial situation, which are [11:528]:

- a. Company costs incurred in creating, developing, producing and marketing the product.
- b. The consumer's concept of the worth of the product in relation to all other products.
- c. The reactions of competition to a new product in an established market or by all manufacturers to a new product concept.



- d. The prevailing economic, social, cultural and political situation and possible future trends in these areas.
- e. The influence of what the company requires the product to achieve in subjective terms of image and prestige as well as the objective terms of contribution to company profitability.

Harold Gault developed an eight point checklist of pricing strategy selection considerations specifically related to defense contracting in his doctoral dissertation, which are [9:34]:

- a. What are the estimated costs and profits for the anticipated contract?
- b. What is the level of confidence for the estimated costs and profits?
- c. What is the expected impact of the anticipated contract upon the profitability of existing business?
- d. What is the variability of the expected impact?
- e. What are the capital requirements?
- f. What is the probability of contract capture as a function of price?
- g. What new business can be expected as a result of contract capture; enhancement of competitive posture?
- h. What are my risk preferences (priorities) for the anticipated contract?

It is quite clear that the establishment of a pricing strategy for a pioneer product in the defense major weapon system market is a complex and risk intensive process. The pricing decision process must consider a broad range of factors and variables from the firms internal and external environment.

### 3. Pioneer Product Pricing Strategies

Yoram Wind states "The high (skimming) versus low (penetration) introductory price alternatives have long been considered the two major choices for the pricing of a new product." [15:378] The new products considered in this study are pioneer products in the defense aerospace industry. Each of these two strategies has its own peculiar requirements for potential use.

The pricing strategy of skimming is defined as ". . . a strategy of high initial prices and large promotional expenditures, followed by lower prices at later stages." [10:174] In terms more associated to corporate objectives the definition would be; ". . . achieving the maximum contribution to profit in the shortest possible time by charging the highest price that the market will bear." [11:529]

The use of this strategy is dependent upon a given set of corporate, buyer and market conditions. The following list of conditions, or significant portion thereof, will normally exist when the skimming strategy is adopted for use.

- When the life cycle of the product is expected to be short - a feature of markets with a high incidence of innovation. [11:529]
- The sales price will be less sensitive early because of lack of competition. [10:174]
- When the target market segment is the premium market, characterized by low volume sales and insensitivity to

price. This market segment is responsive to informative promotion and the overall market segment can be expanded into larger successive segments through later price reductions. [10:174; 11:529]

- High initial price produces early returns and reduces risk of future market uncertainty. [10:174]
- With new product concepts where the buyer has no "measuring rod" for comparisons of value and utility. [11:529]
- When future product modifications and improvements to meet changing consumer's concept of utility can be incorporated without price changes. [11:529]
- Higher initial returns are required to finance production volume increases and high product introduction costs. [10:174; 11:529]
- The corporation may have limited manufacturing facilities to produce the product or a small sales force to promote the product. Therefore a small, but highly profitable premium market segment may be the most economic for the corporation. [11:529]

Although the skimming strategy appears to possess many advantages for the ". . . risk averse, profit satisficing aerospace firm . . . ." [13:218], an equally cogent variety of factors exist to support the alternative strategy of penetration.

The essence of the penetration strategy is to achieve maximum market penetration as early as possible through the use of low initial price, with little or no reduction over time. [10:175; 11:259]

A listing of the corporate, buyer, and market conditions most advantageous for the use of the penetration strategy follows.

- When the corporation is convinced of the long-run demand, with long term profits and capital recovery. [11:530]
- To discourage competition because short to medium term profits appear to be low in comparison to the high investments required for volume production. [11:529]
- There is no premium market segment insensitive to price. Large volume sales are very sensitive to price. [10:175] A very high elasticity of demand is present in the market. [11:529]
- The pioneer product faces a strong possibility of substitute and differentiated product competition very soon after market introduction. [10:175])
- A low price may penetrate an important market segment not yet tapped by existing high priced products. [11:529])

The basic differences between the two pricing strategies are: high profit early when skimming versus moderate profit over the long term when penetrating; long term capacity required to penetrate versus lower commitment to long term capacity for skimming; faster return and lower risk of future market uncertainty for skimming versus higher future risk for penetration.

#### D. FINANCIAL CONDITION AND PRICING STRATEGY

The major weapon system producers, prime contractors, are large publicly held corporations. As such, they are required to provide the public with financial information in the form of a public annual report and reports to the Securities Exchange Commission (SEC) such as the 10K Report. These reports are obtainable by the Government or any other interested buyer. Additionally, several firms specialize in

providing financial information for investors (i.e., Dow-Jones, Moody's, Robert Morris Associates, etc.). There is an abundance of publically available financial information.

In contrast, the pricing strategy of a corporation is generally very closely held, often considered proprietary. A corporation denies competitors and customers knowledge of its pricing strategy to prevent them from realizing a negotiations advantage during business transactions.

If a relationship exists between the pricing strategy and financial condition of a corporation then some level of predictability may be determinable. Analysis of readily available financial information then holds out the possibility of allowing the analyst to determine the proprietary pricing strategy.

#### E. CONCLUSION.

The material presented in this chapter indicates that pricing objectives should support corporate objectives and pricing strategy should support pricing objectives. In addition, financial objectives should support corporate objectives and financial objectives may be related to financial condition. See Figure 1 on following page.



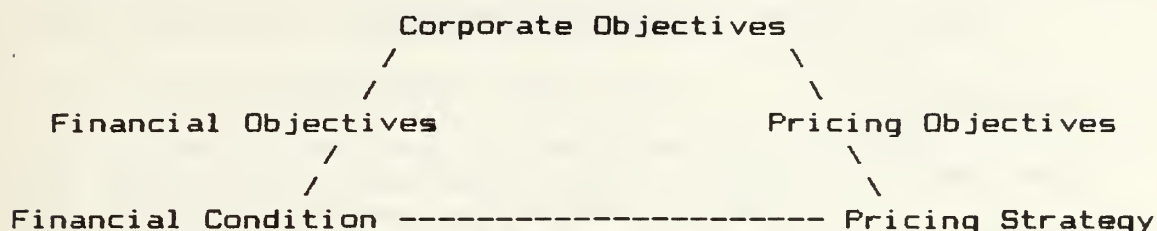


Figure 1. Corporate Interrelationships

Thus there is a basis for hypothesizing a link between financial condition and pricing strategy.

The next chapter will discuss basic aspects of financial condition (i.e., liquidity, profitability, efficiency, and financial strength) and select ratios in each category to use in reflecting financial condition.

#### IV. FINANCIAL RATIOS

##### A. INTRODUCTION

The use of financial ratio analysis in this study will encompass a discussion of: sources of ratios; categorization of selected ratios; selection of ratios; and enumeration of financial statement elements used in the computation of financial ratios.

An analysis using financial ratios must be structured to ensure that uniformity is maintained in the development of the ratios and that the entities being analyzed are similar. Consequently this study concentrates only upon the defense aerospace industry with analysis of prime airframe manufacturers since 1950.

The objective is to select a fairly large number of ratios representative of numerous financial categories that will hold the potential to distinguish between the penetration and skimming pricing strategy.

##### B. SOURCES OF FINANCIAL RATIOS

The six sources of financial ratios used are drawn from four generic areas; professional market analysts, academic textbooks, accounting literature and government studies. The extensive number of potential sources had to be reduced to a manageable level that drew upon representative bases of

knowledge associated with the defense aerospace industry and ratio analysis. The sources used are listed below.

1. Dun and Bradstreet [16:v-vi]
2. Financial Accounting textbook [17:677-685]
3. Financial Management textbook [18:54-61]
4. Financial Analysis textbook [19:60-69]
5. An article recapping recent efforts using financial ratios to predict bankruptcy. [20:51-60]
6. Financial Analysis of Major Defense Contractors prepared for the Assistant Secretary of the Navy, (Shipbuilding and Logistics). [21]
7. Defense Financial Investment and Review (DFAIR) [14: appendix 3]

#### C. CATEGORIZATION OF FINANCIAL RATIOS

The categorization scheme of ratios used in this research ties to the corporate goals previously discussed. The intention is to associate ratios within designated categories to stated corporate goals. By so doing it is believed that the hypothesized relationship between financial condition and pricing strategy will be illuminated. The categories selected are enumerated below.

##### 1. Profitability

Profitability ratios measure the firms ability to generate a return on its sales or investments. Recall that skimming and penetration differ in the level and speed with which return is generated, with skimming providing a higher, faster return.

## 2. Financial Strength and Liquidity

Financial strength ratios reflect the capital structure of the firm and long term risk. Liquidity ratios indicate the ability of the firm to generate cash in the short run and also reflect aspects of risk. Recall that skimming and penetration differ in their risk characteristics.

## 4. Asset Utilization

Asset utilization ratios compare the level of sales generated with measures of investment in assets. Such ratios reflect how well capacity is being utilized. Recall that skimming and penetration differed in their apparent capacity requirements.

## D. SELECTION OF FINANCIAL RATIOS

The selection of specific financial ratios for consideration in the study was based upon a variety of factors. First, simplicity. The elements of the ratio had to be identifiable from the balance sheet, income statement or the statement of change in financial position without manipulation using information from the notes to the financial reports. It was desired that the duplication of the analysis by a program manager (PM) or procurement contracting officer (PCO) be uncomplicated and relatively easy.

Second, coverage. A relatively large number of ratios are used, drawing from each of the four categories. Reduction in the number of ratios is accomplished through statistical analysis with retention of those ratios that possess the greatest predictive value.

Third, familiarity. Ratios must be commonly used, recognized and cited in texts, publications etc...

Lastly, representativeness. The components of the selected ratios should contain as many information elements as possible from the balance sheet, income statement or statement of change in financial condition while seeking to reduce redundancy.

The following listed ratios, by category, have been selected for use in this study.

(1) Profitability.

- Return on Equity =  $\frac{\text{net income}}{\text{stockholder equity}}$
- Return on Sales =  $\frac{\text{net income}}{\text{sales}}$
- Return on Assets =  $\frac{\text{net income}}{\text{total assets}}$

(2) Financial Strength.

- Debt to Equity Ratio =  $\frac{\text{total liabilities}}{\text{stockholder equity}}$
- Times Interest Earned =  $\frac{\text{op. income}}{\text{interest expense}}$
- Debt to Asset Ratio =  $\frac{\text{total liabilities}}{\text{total assets}}$



(3) Liquidity.

- Quick Ratio =  $\frac{\text{cash} + \text{acct. rec.} + \text{mkt. sec.}}{\text{current liabilities}}$
- Current Ratio =  $\frac{\text{total current assets}}{\text{total current liabilities}}$
- Sht. Term Debt/Equity =  $\frac{\text{current liabilities}}{\text{stockholder equity}}$
- Cash Ratio =  $\frac{\text{cash}}{\text{current liabilities}}$
- Inventory Turnover =  $\frac{\text{annual sales}}{\text{inventory}}$
- Receiveables Turnover =  $\frac{\text{annual sales}}{\text{accounts receivable}}$
- Asset Liquidity =  $\frac{\text{working capital}}{\text{plant assets}}$

(4) Asset Utilization

- Capital Investment =  $\frac{\text{capital expenditures}}{\text{sales}}$
- Assets Turnover =  $\frac{\text{annual sales}}{\text{total assets}}$

E. FINANCIAL STATEMENT ELEMENTS

The financial ratios enumerated above make use of sixteen financial statement elements broken down as follows.

1. Ten from the balance sheet.
2. Five from the income statement.
3. One from the statement of change in financial position.

Figure 2 contains a listing of the financial statement elements required by source.

---

A. Corporation:

B. Statement Year:

C. Balance Sheet Elements:

Cash:

Acct. Rec:

Mkt Securities:

Inventories:

Total Current Assets:

Plant, Property, Equipment:

Total Non-current Assets:

Total Assets:

Current Liabilities:

Long Term Liabilities:

Total Liabilities:

Stockholders Equity:

D. Income Statement Elements.

Sales:

CGS:

Operating Income:

Depreciation:

Interest Expense:

Tax:

Net Income:

E. Statement of Change in Financial Position Element.

Expenditures for Plant, Property, Equipment:

F. Earnings Per Share:

---

Figure 2. Financial Statement Elements Worksheet

## F. CONCLUSION

The ratios selected provide coverage of the financial information in public reports, are easily indentifiable in

those reports and are targeted to corporate goals. The number of ratios is sufficiently large yet not excessive for analytical purposes.

The next chapter will utilize the statistical techniques of correlation and regression to determine those ratios that are most highly associated with pricing and to assess the strength of the hypothesized relation between financial condition and pricing strategy.

## V. DATA ANALYSIS

### A. INTRODUCTION

This chapter describes the data source, statistical analysis conducted, and results of the analysis. The actual information elements and computed ratios for each year and contract are not individually presented.

### B. COMPOSITION OF DATA

Thirty five contracts were selected from the U.S. Military Aircraft Cost Handbook [7]. Data from the three years prior to and from the year of contract initiation were selected for analysis. Twenty one financial information elements were gathered for each year, when the information was available. These twenty one elements were used to construct the fifteen financial ratios, from the four categories of financial condition, listed in Chapter IV. The financial information elements were extracted from annual reports or SEC 10K reports, whichever was obtainable. Slopes of the price reduction curves were taken from the U.S. Military Aircraft Cost Handbook [7].

Figure 3 presents a listing of the contractors, contracts, years used in the study, the price reduction slope and partial or complete information status. Twenty seven complete contracts and eight contracts with partial data, representing eleven aerospace contractors are listed.

Contractor	Contract	Years	Slope	Comp.	Part.
Bell	AH-1S	72-75	0.891	X	
	AH-1T	73-76	1.021	X	
Boeing	B-52G	54-57	0.869	X	
General Dynamics	F102-A	50-53	0.724		X
	F-106A/B	54-57	0.837	X	
	RIM-24B	58-61	0.923	X	
	RIM-2E	58-61	0.930	X	
	RIM-66A	63-66	0.763	X	
	RIM-67A	63-66	0.825	X	
	AGM-78D	70-73	1.088	X	
	BGM-109	77-80	0.943	X	
Gruman	A-6A	58-61	0.829	X	
Lockheed	P-3A	57-60	0.718	X	
	P-3B	62-65	0.910	X	
	S-3A	69-72	0.846	X	
McDonnell Douglas	F101-A/B/C	51-54	0.802		X
	A-4B	52-55	0.834	X	
	A-4C	54-57	0.894	X	
	F-4A/B	56-59	0.834	X	
	A-4E	58-61	0.892	X	
	F-4D	61-64	0.886	X	
	F-15A	70-73	0.917	X	
	F/A-18A	76-79	0.860	X	
North American	F-86D	48-51	0.926		X
	F-86F	48-51	0.870		X
	F-1B/C/ MF-1C	49-52	0.783		X
	F-100A/C	49-52	0.839		X
	F-100D	51-54	0.934	X	
Northrup	F-89D	48-51	0.885		X

Figure 3. List of Contractors and Contracts



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Raytheon	AIM-7F	65-68	0.773	X	
	AIM-7M	77-80	0.880	X	
Republic	F-84F	48-51	0.725		X
	F-105B/D	54-57	0.759	X	
Vought	A-7A/B	62-65	0.852	X	
	A-7D	65-68	0.950	X	

---

Figure 3. List of Contractors and Contracts (con't)

### C. CORRELATION ANALYSIS

A correlation analysis was conducted between each financial ratio and the slope of the price reduction curve. The purpose was to determine the sign of the relationship. Prior to the analysis an expected sign was hypothesized for each category of financial ratios based upon their characteristics in relation to either the skimming or penetration pricing strategy.

High profitability ratios may be associated with a continuing demand by the firm for high return projects. Lower return projects would be more likely to reduce overall return and lower overall profitability. Consequently firms with high profitability ratios are expected to have a stronger preference for skimming. Since skimming is reflected in low slope values, a negative correlation

between profitability measures and price reduction slope is expected.

Low values for the liquidity ratios indicate a relatively poor liquidity position, relatively higher short term risk, and the need to adopt a pricing strategy that provides for faster return - i.e., skimming. The hypothesis is for an association of low liquidity ratios with low slope values or a positive correlation. An exception is the Short Term Debt to Equity ratio, where lower values may indicate a less pressing need for cash, and consequently a negative correlation is hypothesized.

Referring to the financial strength ratios, high values for Debt/Equity and Debt/Asset and low values for Times Interest Earned are indicative of greater long term risk. The penetration strategy requires returns over the long run to be successful while skimming reduces the risk of future uncertainty. It is expected that firms with poorer long run financial strength will prefer the skimming strategy because of its reduction of future uncertainty. Consequently a negative correlation of slope with Debt/Equity and Debt/Asset, and a positive correlation with Times Interest Earned is expected.

The first asset utilization ratio, Capital Investment, relates investment in new capacity to the level of sales. Higher ratios indicate an expansion of capacity. The second asset utilization ratio, Asset Turnover, relates sales to

existing capacity. Lower ratios indicate poorer utilization of capacity. It is expected that firms that are adding additional capacity or not fully using existing capacity will desire a pricing strategy that increases the probability that their capacity is utilized. The low initial price associated with the penetration strategy should increase the chance of product acceptance, widen the potential market and enhance utilization of capacity. Consequently a positive association between slope and Capital Investment, and a negative association between slope and Asset Turnover are hypothesized.

Figure 4, on the following page, shows the actual correlation for each financial ratio.

The predicted signs of the correlation coefficients are found for all of the ratios in the profitability and asset utilization categories. Two, of three, financial strength ratios and four, of seven, liquidity ratios have the predicted signs. While the observation of "incorrect" signs is unfortunate, within both the financial strength and liquidity categories, the ratio(s) with the wrong signs are also the ones with the smallest correlations. Thus across the four categories, the ratios most strongly associated with the price reduction slope exhibited the expected relationship.

---

Category/Ratio	Corr. Coef.	Predicted Sign
Profitability		
Return on Equity	-.277	-
Return on Sales	-.129	-
Return on Assets	-.200	-
Financial Strength		
Debt/Equity	-.052	-
Times Interest Earned	-.040	+
Debt/Asset	-.083	-
Liquidity		
Quick Ratio	-.030	+
Current Ratio	+.249	+
Short Term Debt/Equity	-.182	-
Cash/Current Liabilities	-.112	+
Inventory Turnover	-.045	+
Accounts Receivable Turnover	+.171	+
Asset Liquidity	+.130	+
Asset Utilization		
Capital Investment Ratio	+.248	+
Asset Turnover	-.229	-

---

Figure 4. Financial Ratio Correlation Behavior

#### D. LINEAR REGRESSION ANALYSIS

A linear regression analysis was conducted using all fifteen financial ratios to predict the slope of the price reduction curve. The primary objective was to determine if a reasonable r-squared value existed for ratios from any of the four years, and which year had the largest value. The results of the regression analysis are listed below by year in descending order.

- Year 0, r-squared = 59.2%.

- Year 1, r-squared = 73.3%.
- Year 2, r-squared = 63.4%.
- Year 3, r-squared = 47.3%.

Based upon these results it was concluded that year 1 possessed the greatest potential as a predictive model. The desire for simplicity in the model as a tool for use by a PCO caused the other years to be dropped from further analysis.

#### E. STEPWISE REGRESSION

The next analytical operation undertaken was a forward selection, stepwise regression to determine the order of contribution of the independent variables to the model. The results of this analysis were used in the next process, to formulate a linear regression model using the least number of variables to obtain a reasonably high r-squared value. Figure 5, lists the financial ratio selection sequence, r-squared value for each ratio and the cumulative r-squared value for the model after the inclusion of that ratio.

---

Ratio	R-squared	Cumulative R-squared
Inventory Turnover	22.20	22.20
Short term Debt/Equity	15.20	37.40
Return on Assets	6.63	44.03

---

Figure 5. Financial Ratios Selection Sequence



---

Ratio	R-squared	Cumulative R-squared
Return on Equity	3.84	47.87
Times Interest Earned	5.38	53.25
Capital Investment	5.53	58.78
Quick Ratio	4.09	62.87
Current Ratio	5.44	68.31
Asset Turnover	2.36	70.67
Return on Sales	1.33	72.00
Debt/Asset	0.28	72.28
Debt/Equity	0.80	73.08
Asset Liquidity	0.07	73.15
Cash Ratio	0.11	73.26
Receivables Turnover	0.03	73.29

---

Figure 5. Financial Ratios Selection Sequence (con't)

#### F. SEQUENTIAL ADDITION OF VARIABLES TO THE REGRESSION MODEL

Based upon the results of the stepwise regression several standard regressions were computed, adding one variable at a time, to build a linear model that utilized as few variables as possible while achieving a relatively high level of predictive ability. The addition of variables was stopped when the F-statistic and r-squared adjusted value

started to decline, signifying little value from the addition of further variables.

Three separate models are presented in Figures 6, 7, and 8. There is reason to highlight each for consideration. Model #1 (Figure 6), including six ratios, had the highest overall F-statistic of all models considered. Model #2 (Figure 7), including eight ratios, had the second highest F-statistic and the r-squared value was materially increased by the inclusion of the two additional ratios. Model #3 (Figure 8), with nine ratios, has the highest r-squared adjusted value of all models considered.

---


$$\text{Slope} = 1.20 - 0.007x_1 - 0.181x_2 - 6.05x_3 + 1.59x_4 + 0.0008x_5 + 1.71x_6$$

<u>Ratio</u>	<u>Coeff</u>	<u>Category</u>
x <sub>1</sub> Inventory Turnover	-0.007	Liquidity
x <sub>2</sub> Short Term Debt/Equity	-0.181	Liquidity
x <sub>3</sub> Return on Assets	-6.05	Profitability
x <sub>4</sub> Return on Equity	+1.59	Profitability
x <sub>5</sub> Times Interest Earned	+0.0008	Fin. Strength
x <sub>6</sub> Capital Investment	+1.71	Asset Utilization
r-squared	58.8%	
r-squared adjusted	43.3%	
F-statistic	3.802	
significance	0.067	

---

Figure 6. Regression Model #1.

---


$$\text{Slope} = 1.10 + 0.008x_1 - 0.197x_2 - 7.14x_3 + 2.04x_4 + 0.0009x_5 + 2.58x_6 - 0.234x_7 + 0.103x_8$$

<u>Ratio</u>	<u>Coeff</u>	<u>Category</u>
$x_1$ Inventory Turnover	+0.008	Liquidity
$x_2$ Short Term Debt/Equity	-0.197	Liquidity
$x_3$ Return on Assets	-7.14	Profitability
$x_4$ Return on Equity	+2.04	Profitability
$x_5$ Times Interest Earned	+0.0009	Fin. Strength
$x_6$ Capital Investment	+2.58	Asset Utilization
$x_7$ Quick Ratio	-0.234	Liquidity
$x_8$ Current Ratio	+0.103	Liquidity
r-squared	68.3%	
r-squared adjusted	50.2%	
F-statistic	3.772	
significance	0.06284	

---

Figure 7. Regression Model #2

---

$$\text{Slope} = 1.12 + 0.0007x_1 - 0.231x_2 - 8.14x_3 + 2.20x_4 + 0.0008x_5 + 3.08x_6 - 0.204x_7 + 0.076x_8 + 0.052x_9$$

<u>Ratio</u>	<u>Coeff</u>	<u>Category</u>
$x_1$ Inventory Turnover	+0.0007	Liquidity
$x_2$ Short Term Debt/Equity	-0.231	Liquidity
$x_3$ Return on Assets	-8.14	Profitability
$x_4$ Return on Equity	+2.20	Profitability
$x_5$ Times Interest Earned	+0.0008	Fin. Strength
$x_6$ Capital Investment	+3.08	Asset Utilization
$x_7$ Quick Ratio	-0.204	Liquidity
$x_8$ Current Ratio	+0.076	Liquidity
$x_9$ Asset Turnover	+0.052	Asset Utilization
r-squared	70.7%	
r-squared adjusted	50.4%	
F-statistic	3.48	
significance	0.06273	

---

Figure 8. Regression Model #3.

## VI. CONCLUSION, RECOMMENDATIONS AND OBSERVATIONS

### A. CONCLUSION

It is the researcher's conclusion that the nine variable linear regression model for the year prior to the contract, year 1, offers the most potential as a pricing strategy predictor. This model possesses a high r-squared value, 70.7%, the highest r-squared adjusted value, 50.4%, and the third highest F-statistic, 3.48. Beyond this point the addition of more variables causes a reduction in the r-squared adjusted value and the F-statistic without a material increase in the r-squared value. All four of the ratio categories are represented by the nine ratios in the model. It is recognized that the model requires validation with other sample populations before any firm conclusions can be drawn concerning it's predictive capacity.

### B. RECOMMENDATIONS

- (1) That the year 1, nine variable model be validated further with different sample populations.
- (2) That the basic methodology be tested in other segments of the defense acquisition market, for example; ships, ground weapons, ground transportation, etc..
- (3) That the percent change in ratio values from year to year be used as the independent variables for a similar analysis.

- (4) That interperiod cost allocation methods determined for the years of the contracts from public reports be used as the independent variables following the methodology used by Dr. Greer.

### C. OBSERVATIONS

Four observations are delineated below that should be considered by any user of the model or anyone conducting further research using the model as a starting point. It was not within the scope of this research to attempt to incorporate every identifiable factor into the analysis. Again, this effort should be viewed as an initial step into the use of predicting pricing strategy from financial health.

- (1) Much of the financial data used in this study is drawn from contracts that are not recent. A thirty year time frame is encompassed; 1950 - 1980. Twenty eight of the thirty five contracts included, 80%, draw upon financial data resulting from operations prior to 1970; more than sixteen years old.
- (2) During the thirty year period of operations that produced the financial data used many changes occurred in Generally Accepted Accounting Principles (GAAP) that affected the manner in which financial data was accumulated and publicly reported. Implementation of Cost Accounting Standards (CAS), beginning in 1972, has had a major impact upon defense contractor accounting practices. Further research upon or use of the model with financial data drawn from operations following the imposition of Cost Accounting Standards (CAS) may produce different results.
- (3) Commencing with the Commission of Government Procurement (COGP) in 1972 the defense acquisition environment has been subjected to ever increasing statutory and regulatory change. The current market is vastly different from the market that existed prior to 1972. Consequently pricing strategy



selection criteria have evolved in response to the changing environment.

- (4) The effects of the Tax Reform Law of 1986 upon corporate financial condition is yet to be determined. However, it will have an affect upon the financial data available in public sources. That affect will not be found in the financial data used to develop this model.

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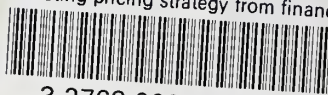
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